## UNCLASSIFIED

# AD 400 665

Reproduced by the

ARMED SERVICES TECHNICAL INFORMATION AGENCY
ARLINGTON HALL STATION
ARLINGTON 12, VIRGINIA



# UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

ACTIA FILE COPY

ON GEOMAGNETIC FLUCTUATION, IN REGIONS REMOTE FROM HIGH-ALTITUDE JUCLEAR BURSTS

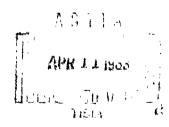
Edward C. Field

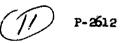
(9)

July 1962

400 665

NO OTS





W 08-5204

(4) NH (5) 1/39208

### ON GEOMAGNETIC FLUCTUATIONS IN REGIONS REMOTE FROM HIGH-ALTITUDE NUCLEAR BURSTS

g 'Edward C. Field'

Consultant to The RAND Corporation, Santa Monica, California

(10 4P. 5refor

It is the purpose of this letter as suggest that ionospheric ionization caused by beta particles resulting from the decay of detonation-produced neutrons is capable of causing an artificial geomagnetic solar flare effect (s.f.,) in regions several in regions several thousands of kilometers from a high-altitude nuclear burst. Although geomagnetic fluctuations due to a bomb-produced s.f.e. were noted in the Pacific following the Hardtack detonations, (NoNich, 1959), we will be smaller disturbances occurring much further from the Coopers advanced by Crain and Tamarkin (1961), which concepts advanced by Crain and Tamarkin (1961), which consider the seminated for an explanation of much of what follows, ware used to make estimates concerning the characteristics of this effect.

Comparisons with some experimental results are also made.

Geomagnetic fluctuations following the Orange detoration were observed at Palomar and Isabella in Southern California, and Resolute Bay in the Arctic (Benioff, as reported by Hodder, [1961]). These stations were all sufficiently remote from ground zero so as to preclude the possibility of effects due to direct or scattered radiation.

Also, the enset times were too rapid to be explicable on the basis of

<sup>\*</sup>Any views expressed in this paper are those of the author. They should not be interpreted as reflecting the views of The RAND Corporation or the official opinion or policy of any of its governmental or private research sponsors. Papers are reproduced by The RAND Corporation as a courtesy to members of its staff.

slowly propagating hydromagnetic phenomena. (The announced time for Orange was August 12, 1958, at 10:30:08 GMT (AEC, 1959) and Benioff's measurements show fluctuations beginning several tenths of a second after this.) The disturbances were "fractional gamma" in magnitude, and were mainly in the horizontal components of the earth's field.

Typical onset times of ionization due to neutron-decay betas can be estimated to be the order of tenths of a second for a burst-observer distance of a few thousand kilometers. This is in qualitative agreement with the above-quoted measurements. Also, investigations not reported here show that neutrons originating in excess of approximately twenty or thirty kilometers above Johnston Island would have access to geomagnetic field lines passing through the Southern California and Resolute Bay stations.

The persistent ionization produced by neutron-decay betas should lie in the upper D and lower E regions, which is the altitude range in which the current sheets responsible for geomagnetic fluctuations are generally assumed to exist. An order of magnitude estimate of the size of the resulting artificial s.f.e. can be made by noting that the strength of a magnetic disturbance is approximately proportional to the overhead current strength and hence the overhead ionization density. (This is, of course, oversimplified as height variations in the ionization and the collision frequency also play a role.) Thus, if the ambient, local ionization density,  $N_{\rm O}$ , corresponds to a local sq magnetic fluctuation,  $\Delta H_{\rm O}$ , then a bomb-induced additional ionization,  $\delta n$ , will produce a geomagnetic fluctuation,  $\delta H_{\rm O}$ , which is given approximately by

$$\delta H \sim \frac{\delta n}{N_O} \Delta H_O \qquad (1)$$

 $\Delta H_{\rm c}$  is available as a function of local time and geomagnetic latitude in various references (e.g., Critical Tables, 1929). 8n depends on the positions of the detonation and observation points, and is approximately proportional to the bomb yield. It can be conservatively estimated (Crain and Tamarkin, 1961) that an average of some 50 ion-pairs per cc could be formed in a layer of atmosphere 20 km thick and covering about half the earth in 1 second following the detonation of 1 megaton of fission yield. If this figure is taken as typical, on may be estimated to be the order of 100 ion-pairs per cc for a weapon in thousand electrons per cc is reasonable for the altitudes in question under nighttime conditions, and AH can be found from the preceding reference to be a few gamma in Southern California at the time of Orange. An insertion of these numbers in Eq. (1) indicates that SH would be the order of tenths of a gamma in Southern California following Orange. This is quite compatible with the observed fractional gamma magnitudes.

We mention in conclusion that the persistence time of ionization has been examined, and at this point we are unable to explain the fact that the fluctuations appear to have lasted for only a few seconds.

Their small amplitude relative to the background noise could be a factor, however.

#### REFERENCES

- AEC Release B-39, March 10, 1959
- Crain, C. M., and P. Tamarkin, "A Note on the Cause of Sudden Monization Anomalies in Regions Remote from High Altitude Nuclear Bursts," J. Geophys. Research, Vol. 66, 1961, pp. 35-39.
- Hodder, D. T., "An Outline of Magnetic, Electromagnetic, and Telluric Detection for Nuclear Blasts," North American Aviation, Irac., SID 61-9, 21 November 1960.
- International Critical Tables, McGraw-Hill Book Co., Vol. VI, 1929, p. 449.
- McNish, A. G., "Terrestrial Magnetic and Ionospheric Effects Associated With Bright Chromospheric Eruptions," Terr. Mag. and Atmos. Elect., Vol. 42, 1937, p. 109.
- McNish, A. G., "Geomagnetic Disturbances Due to Nuclear Explosions," J. Geophys. Research, Vol. 64, 1959, p. 2253.